MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

EEL2186 – CIRCUITS AND SIGNALS

(All sections / Groups)

7 OCTOBER 2016
3:00 PM – 5:00 PM
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 8 pages including cover page with 4 Questions only.
2. Attempt **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. Tables of Laplace Transform pairs and properties are attached in Appendices A and B for your reference.

Question 1

a) Define the following network graph terminologies:

i) Mesh [1 mark]
ii) Co-Tree [1 mark]
iii) Link [1 mark]

b) Using the relevant equations, find the even and odd components for the following function:

$$f(t) = 3t + t^2$$

[2 +2 marks]

c) Determine whether the given function is an energy or power signal.

$$f(t) = \frac{1}{2}u(t)$$

[4 marks]

d) Sketch as many trees as possible for the graph below in **Figure Q1d**, (be sure to label nodes and branches clearly): [5 marks]

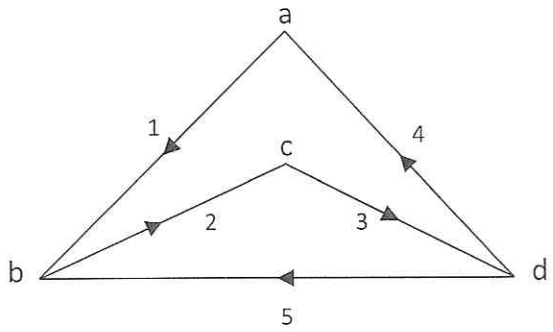

Figure Q1d

Continued...

e) For the given network graph in **Figure Q1e**, with nodes (a, b, c and d), tree branches (solid lines) and co-tree links (dotted lines):

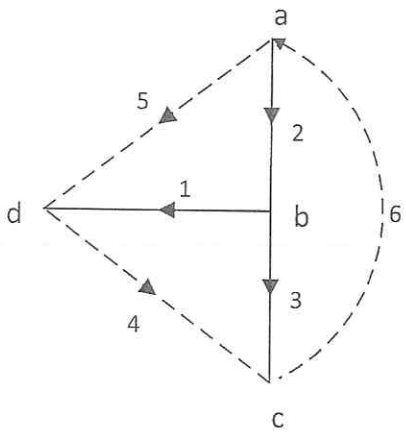

Figure Q1e

i) Draw and label all the available fundamental loops [3 marks]
ii) Find the fundamental loop matrix D [6 marks]

Continued...

Question 2

a) Two signals are as described below:

$$f_1[n] = \{\ldots 0\ 1\ 3\ 6\ 7\ 4\ 0 \ldots\}$$
$$f_2[n] = \{\ldots 0\ 2\ 9\ 6\ 5\ 5\ 0 \ldots\}$$

Perform the convolution of the above signals using the convolution table method. Express the output of the convolution, $y[n]$, in sequence form. [9 marks]

b) The pole-zero plot of a system is as given in **Figure Q2b** below:

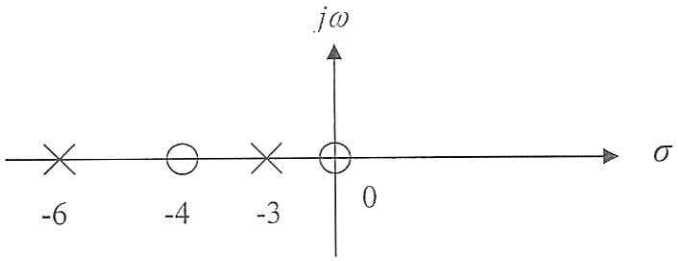

Figure Q2b

i) Obtain the transfer function, $H(s)$ of the system based on the pole-zero plot above. [2 marks]

ii) Hence, determine the step response, y(t) of the system. [6 marks]

c) The differential equation below describes a Linear Time-Invariant (LTI) electric system with an input $x(t)$ and output $y(t)$:

$$\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = 10x(t); \text{ where } x(t) = u(t)e^{-4t}$$

Assuming zero initial conditions, solve for the response, $y(t)$. [8 marks]

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Question 3

a) Consider the circuit shown in **Figure Q3a**.

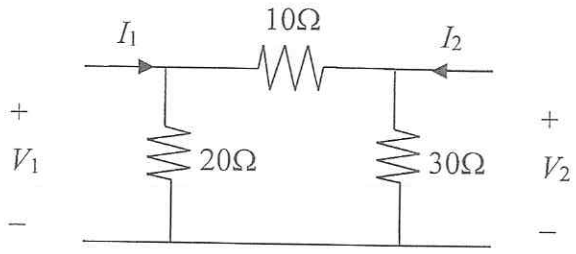

Figure Q3a

i) Determine the z-parameters of the circuit. Given that,

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}.$$

[12 marks]

ii) An ideal voltage source of 10V is connected across the input terminals of the circuit. A load of 50Ω is connected across the output terminals. Find the currents I_1 and I_2. [5 marks]

b) Find the state-space representation for the circuit shown in Figure Q3b. Take v_s as the input and i as the output. [8 marks]

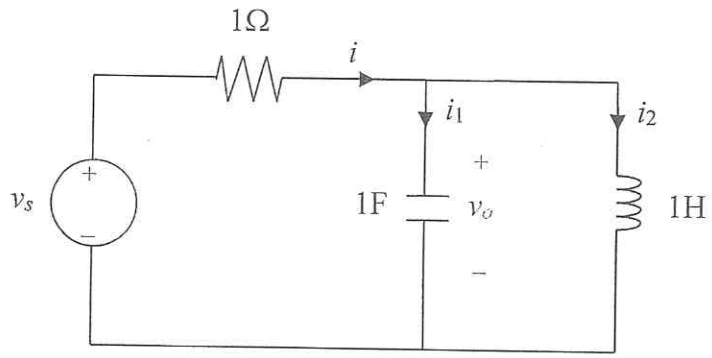

Figure Q3b

Continued...

Question 4

a) Describe two of the properties for the Hurwitz Polynomial. [4 marks]

b) Check whether the given polynomial $P(s) = s^4 + s^3 + 5s^2 + 3s + 4$ is Hurwitz or not. [9 marks]

c) Find the order of a LP filter by Butterworth approximation procedure for the given specifications:

Maximum allowable pass band attenuation $A_p = 2dB$

Maximum stop band attenuation $A_s = 80dB$

Pass band limiting frequency = 4 MHz

Stop band edge frequency = 12 MHz

[4 marks]

d) Find the transfer function of Butterworth filter when order of the filter is:

i) n = 2

ii) n = 3

[8 marks]

End of paper.

Appendix A: Table of Laplace Transform Pairs

No.	*t*-domain function	*s*-domain transform
1.	$\delta(t)$	1
2.	$u(t)$	$1/s$
3.	$tu(t)$	$1/s^2$
4.	t^n	$\frac{n!}{s^{n+1}}$
5.	e^{-kt}	$\frac{1}{s+k}$
6.	$t^n e^{-kt}$	$\frac{n!}{(s+k)^{n+1}}$
7.	$\sin\omega t$	$\frac{\omega}{s^2+\omega^2}$
8.	$\cos\omega t$	$\frac{s}{s^2+\omega^2}$
9.	$e^{-kt}\sin\omega t$	$\frac{\omega}{(s+k)^2+\omega^2}$
10.	$e^{-kt}\cos\omega t$	$\frac{s+k}{(s+k)^2+\omega^2}$
11.	$t\sin\omega t$	$\frac{2\omega s}{(s^2+\omega^2)^2}$
12.	$\sinh\beta t$	$\frac{\beta}{s^2-\beta^2}$
13.	$\cosh\beta t$	$\frac{s}{s^2-\beta^2}$
14.	$\sin(\omega t+\phi)$	$\frac{s\sin\phi+\omega\cos\phi}{s^2+\omega^2}$
15.	$2\lvert k\rvert e^{-\sigma t}\cos(\omega t-\varphi)$, where $k=\lvert k\rvert\angle\varphi$	$\frac{k}{s+\sigma+j\omega}+\frac{k^*}{s+\sigma-j\omega}$
16.	$f(t)$ periodic with period T	$\frac{1}{1-e^{-Ts}}\int_0^T f(t)e^{-st}dt$

Appendix B: Table of Laplace Transform Properties

Operations	$f(t)$	$F(s)$
1. Multiplication by scalar	$kf(t)$	$kF(s)$
2. Scaling	$f(kt),\ k \geq 0$	$\frac{1}{k}F\left(\frac{s}{k}\right)$
3. Addition and subtraction	$f_1(t) \pm f_2(t)$	$F_1(s) \pm F_2(s)$
4. Time shift	$f(t-t_o)u(t-t_o)$	$F(s)e^{-st_o}$
5. Frequency shift	$f(t)e^{\alpha t}$	$F(s-\alpha)$
6. Time differentiation	$\frac{df(t)}{dt}$	$sF(s) - f(0)$
	$\frac{d^2f(t)}{dt^2}$	$s^2F(s) - sf(0) - f'(0)$
7. Time integration	$\int_0^t f(\tau)d\tau$	$\frac{1}{s}F(s)$
8. Initial value	$\lim_{t\to 0} f(t)$	$\lim_{s\to\infty} sF(s)$
9. Final value	$\lim_{t\to\infty} f(t)$	$\lim_{s\to 0} sF(s)$
10. Frequency differentiation	$tf(t)$	$-\frac{dF(s)}{ds}$
11. Frequency integration	$\frac{f(t)}{t}$	$\int_s^\infty F(\tilde{s})d\tilde{s}$
12. Convolution	$f_1(t) * f_2(t)$	$F_1(s)F_2(s)$